XXIII. *Remarks on* Gnetum. *By the late* WILLIAM GRIFFITH, *Esq., F.L.S., Madras Medical Service. Communicated by* A. HENFREY, *Esq., F.R.S., F.L.S., Professor of Botany, King's College.*

Read April 21st, 1859.

PREFATORY NOTE BY PROF. HENFREY.

THE following paper is the original from which were derived the particulars communicated by Dr. Lindley, in the article *Gnetaceæ*, in his 'Vegetable Kingdom;' and it is now brought forward under the following circumstances.

My curiosity was excited by Mr. Griffith's account, quoted by Dr. Lindley, of the existence of a long convoluted suspensor in the ovule of *Gnetum*. It appeared to me that this indicated an additional affinity between the *Gnetaceæ* and the *Coniferæ* and *Cycadaceæ*, and that this would be still more striking if it were accompanied by the phenomena of polyembryony, such as are met with in the undoubted Gymnosperms. On examination of some specimens, I found that the lower end of the long convoluted suspensor does divide into a number of distinct processes, as in Conifers, and that the embryo is developed at the end of one of these. I now became anxious to examine some flowers in an early stage of development with a view to ascertain if *Gnetum* produced *corpuscula*; which I thought might have been overlooked by Mr. Griffith, his Memoir having been written before the publication of Mr. Brown's celebrated Memoir on the Plurality of Embryos in the *Coniferæ*.

Through the kindness of Dr. Hooker, I obtained from the Kew Museum a supply of specimens of *Gnetum* in various stages of growth. From the same friend I learnt that the original Memoir of Mr. Griffith was in the hands of the Secretary of the Society, and, with the consent of Dr. Lindley, Mr. Bennett placed the paper in my hands. The study of this paper, under the light of my own observations, has led me to attach great importance to it, and I have recommended its publication before communicating the results of my investigations, on account of the author's having forestalled me in the greater part of the facts important in the history of development of this genus, and rendered it unnecessary for me to do more than supplement his observations in a few points, before entering upon the general conclusions I have drawn from his and my own studies.

I hope shortly to offer a paper on this subject for the consideration of the Linnean Society, and shall merely say at present, that my investigations lead me to look very favourably upon the opinion expressed by Prof. J. G. Agardh, in his new 'Theoria Systematis Plantarum,' that the *Gnetaceæ* are related even more closely to the *Loranthaceæ* than to the *Coniferæ*.

London, January 7, 1859.

This paper owes its existence to Dr. Lindley, who with his usual kindness pointed out to me this, among several other genera, as an interesting subject for study. In glancing over the history of this genus, we find that very little additional information had been acquired upon its structure from the period of its original publication by Linnæus, from whose character all the subsequent ones have been more or less derived, until the appearance of Dr. Brown's Memoir relative to the character and description of *Kingia* appended to King's Voyage*. Previous to the appearance of this important publication, all botanists who had noticed this genus had ascribed to the female flower the ordinary structure. It will hereafter be seen that all those who have formed this opinion of the structure of *Gnetum* have examined the female flowers at a rather late period.

Dr. Brown, in the Memoir above referred to, p. 23, gives it as his opinion, that in *Cycadeæ*, *Coniferæ*, *Ephedra*, and *Gnetum*, the ovarium is either altogether wanting, or so imperfectly formed that the ovulum itself becomes directly exposed to the action of the pollen. He further states that "the similarity of the female flower in *Cycadeæ* and *Coniferæ* to the ovulum of other phænogamous plants, as I have described it, is indeed sufficiently obvious to render the opinion here advanced not altogether improbable; but the proof of its correctness must chiefly rest on a resemblance, in every essential point, being established between the inner body in the supposed female flower in these tribes, and the nucleus of the ovulum in ordinary structures, not only in the early stage, but also in the whole series of changes consequent to fecundation. Now, as far as I have yet examined, there is nearly a complete agreement in all these respects."

After repeated examinations of *Cycas*, *Gnetum*, and *Agathis*, in their growing states, it may perhaps not be considered presumptuous in me to add my feeble testimony to the extreme accuracy of this statement of Dr. Brown †.

Professor Lindley, in his valuable 'Introduction to the Natural System of Botany,' while he admits to the fullest extent Dr. Brown's notions on *Cycadeæ* and *Coniferæ*, appears to entertain the old opinion as to the structure of *Gnetum*; and here it is again evident that this truly philosophical botanist has only examined somewhat advanced female flowers. I find, however, that in his remarks on *Garrya* (Bot. Register, vol. vii. new series, t. 1686), this author has adopted the opinion of Dr. Brown, and speaks of *Gnetaceæ*, a naked-seeded order.

Having thus briefly alluded to the opinions entertained on the structure of this singular genus, I shall now proceed to the consideration of the structure and development of the female flower, which consists of a single naked ovulum.

At a period long before the exsertion of the anthers, the ovula, which lie upon the male flowers, are generally of an oblong form, and consist of a central cellular solid body, enclosed in two envelopes. The outermost of these is fibro-cellular, and divided longitudinally on the upper face, or that nearest the axis, the fissure extending nearly to the base of the ovulum ‡. The inner or second envelope is cellular, and is divided irregularly

* Of this Memoir I have seen only an 8vo copy, in the possession of Dr. Wallich.

† At the same time, Dr. Brown's observations refer only to a period subsequent to the appearance of the additional membrane. (See *Kingia*, p. 25.)

‡ This division is perhaps similar to that which Dr. Brown states to take place in *Dacrydium*.

towards its apex. This envelope does not at this period entirely enclose the nucleus: the points of some of the laciniæ or divisions project occasionally beyond the apex of the outer envelope. The nucleus is an oval or oblong cellular body, rounded off at its apex, which is composed of lax cellular tissue. The next change consists in the commencement of the obliteration of the longitudinal fissure existing along the posticous face of each outer envelope, and of an extension of the inner coat over the nucleus, the apex of which becomes more or less depressed,—the centre of the depression, however, projecting in the form of a cone of a very slight elevation. At the time of flowering, or of the exsertion and dehiscence of the anthers, the fissure originally existing along the upper face of the outer coat has disappeared, with the exception of a small portion at the apex of the ovulum which remains unclosed throughout: the ovula are at this period in some species oblique. The inner envelope is generally entirely enclosed within the outer; the points of its laciniæ reach, however, to the opening existing in the apex of this latter, and occasionally, but by no means universally, project beyond it to a short distance. This coat has undergone scarcely any change, and corresponds in shape to the cavity of the outer envelope. The nucleus is completely covered by both integuments, and its apex, which continues of the same form, is occasionally tinged with brown. Within its substance, which is entirely cellular, and towards its centre, there exists a small cavity, lined with a membranous sac, attached apparently to the apex of the cavity, and containing a number of minute grumous-looking brown masses, arranged without any obvious regularity. This sac* exists at a rather early period, and is developed within a cavity formed by some excavating process.

A short time after the fall of the male flowers an extraordinary change will be found to have occurred, consisting of the very rapid and apparently sudden development of a new membrano-cellular envelope between the second coat and the nucleus. This new formation, which I may term the additional coat, envelopes the nucleus pretty closely, and is continued upwards beyond the apex of the nucleus into a cylindrical tubular process, the mouth of the tube being laciniate or fimbriated. At the period now referred to, its apex barely projects beyond the outer envelope. During its development, no particular change has taken place either in the original integuments or nucleus. At a somewhat later period, the ovula (except in the instance quoted below †), hitherto concealed by the involucrum, will be found exposed, and the outer coat to have become of a green colour: the opening through its apex is distinct, and its direction vertical. The second envelope continues unchanged. The tubular prolongation of the additional or third envelope now projects through the openings in the original coats to a considerable distance. The mouth of the tube is also rather dilated, and the fimbriæ of its margin spread out irregularly and to various extents. The whole of the tubular prolongation has become tinged with brown, in some cases approaching to black.

It is to this stage or period that the descriptions of those authors who attribute a style and stigma to this genus apparently refer. Both Dr. Brown and Prof. Lindley

* This sac I consider to be the amnios, with which it agrees in its development and subsequent disappearance.

† In one species, *G. Brunonianum*, the ovula are at an early period exposed, owing to the obsoleteness of the annulate involucrum.

must likewise advert to this period when they state the nucleus to be surrounded with three envelopes.

The nucleus, which up to the present time continues free from adhesion, has now undergone a slight alteration in figure, consisting in a tendency to constriction towards its apex, which is now invariably more or less brown: its cavity has become enlarged. This constriction may possibly be only apparent, since it may originate in the greater growth of the elevated part of the depression, stated to exist at the apex.

As the young seed progresses in its development, the two outer coats increase in size. The base of the additional membrane adheres to the corresponding portion of the nucleus, the adhesion continuing to increase in extent until it has reached upwards to the commencement of the constriction. The projecting tubular prolongation does not appear to have any regular term of existence; its coloration or sphacelation increases, and at a variable period the exserted portion becomes detached at the situation of the opening of the outer coat. The cavity existing in the nucleus undergoes a corresponding enlargement, and its walls are more irregular. It will be found to contain, about the period of detachment of the exserted portion of the tubular process, a pendulous body of a similar form, attached by a rather broad cellular band to the apex of the cavity. This is the rudimentary amnios, developed originally within the sac, stated to line at a prior period the cavity of the nucleus. As the development proceeds, this body increases in size; it appears to be developed from below upwards, and as it enlarges, the lax cellular attachment undergoes a corresponding diminution, chiefly, I imagine, by pressure. As this body, in which the albumen becomes deposited, increases, the substance of the nucleus gradually disappears, and subsequently merely forms a thin covering to the large and fleshy albumen. The last change which I have traced in the albumen consists in the formation of a cavity within its substance, commencing at its apex, and gradually extending downwards. The corresponding changes consist in the development of pulp and increase of the fibres of the outer coat; in an induration (rather in an induration of the second envelope depending upon the development of fibrous tissue) and development of fibrous tissue in the second envelope, which subsequently becomes brown, subosseous, and fragile. The originally large and distinct openings through both these become narrowed, but never completely filled up—not, at least, by an extension of their own substance. The additional envelope is now membranous and thin, united throughout the greater part of its extent to the thin remains of the nucleus. The included (and permanent) portion of its originally tubular prolongation has become filled up, and is embraced closely within the constricted openings existing through the two outer coats. The remains of the nucleus, owing to the pressure this has undergone during the growth of the albumen (or rather of the amnios and deposition of albumen), finally assume the form of a membrane, united, except towards its apex, which is brown or black and apiculate, to the inner paries of the third coat.

With regard to the development of the embryo, I can add nothing. Although I have examined abundance of fully-formed fruits of two species, I have never observed anything towards the development of the embryo beyond the formation of the cavity in the albumen, and the very rare and partial development of the funiculus, which, moreover, in

the only two cases in which I observed its partial formation laid loose in the cavity. Excepting the want of this essential portion, the seeds were, as I have since ascertained by comparison with seeds with perfect embryos, fully and completely formed.

The following description of the mature seeds is taken from exembryonate specimens, and from the examination of some embryonate seeds of *Gnetum scandens*, brought from Arracan, and communicated, with many other interesting productions, to Dr. Wallich by his late friend Captain R. R. Margrave :—

The mature seed is more or less ovate, obtuse, or acute, and of a reddish-orange colour, and either entirely smooth, or covered with appressed, peltate, silvery cellular scales. Its coats occur in the following order :—

1. *Outer and baccate. Origin : outer envelope of ovule.*—Of this the outer half is entirely cellular ; the inner composed of several layers of fusiform fibres, sharp at both ends, of a yellow colour and shining appearance. They are often punctated, and occasionally marked with incomplete spiral fibres ; they are pungent, and occasion considerable irritation.

2. *Drupaceous : originating from the second envelope of the ovule.*—This is externally sulcate, the innermost fibres of the outer coat being lodged in these sulci ; it is of a brown colour and nearly osseous texture, composed of cells, the innermost series of which are arranged transversely, and a great number of longitudinally-disposed fibres, which are longer and of much less diameter than those of the outer baccate coat.

3. *Fibro-cellular coat. Origin : the additional envelope, and chief part of the nucleary membrane.*—The external part, which is composed of fibres similar to those of the drupaceous coat, arranged longitudinally, is terminated by the persistent and now woody portion of the originally tubular prolongation, the apiculus being lodged in the opening existing even at this period in both the outer coats : its apex is discernible exteriorly at the corresponding end of the seed, but does not, however, project beyond the level of the outer coat. The internal portion forms the

4. *Cellular and membranous envelope. Origin : the circumferential tissue of the nucleus.*—This adheres to the preceding throughout the greater part of its extent. Towards the apex, where it is thinnest, most membranous and sphacelated, it is free, and it is terminated by a conical point (the original elevated portion of the centre of the depressed apex of the nucleus) : it is free from adhesion with the former coat. The point, however, always separates with the albumen, the upper portion of which it covers somewhat in the manner of a cap.

5. *Albumen. Origin : a deposition in the tissue of the amnios.*—This fills exactly the cavity of the last-mentioned envelope ; it is of considerable size, fleshy, and abounds in feculent granules. Around its apex an indistinct areola is visible, and to its extreme apex are attached the remains of the originally lax, cellular attachment ; its base is likewise marked with a depressed, indistinct areola. Along its centre, and occupying the *upper half** of this portion, there is a cavity of considerable size, which tapers off in-

* With regard to the axis at least ; otherwise the base of the original amnios corresponds to the apex of the nucleus.

feriorly, terminating towards the middle of the long diameter of the albumen; the tissue, however, on the same line, and between it and the apex of the albumen being more dense, and having a peculiar appearance. The walls of this cavity are rugged and irregular. To the upper portion, and to one side of the cavity, is attached the embryo by means of an enormously long, tortuous, and spirally but irregularly-twisted cellular funiculus, the cells being much elongated and twisted. Its length varies, when moderately pulled out, from $3\frac{1}{2}$ to 5 inches, the length of the fruit being 1 inch. This funicle, as well as the extremely similar one of *Cycas*, has the property of contracting when immersed in water. When *in situ* it is tolerably closely packed; it is dilated towards its attachment with the embryo. The embryo itself is more or less ovate, its radicle tapering off superiorly, and being completely continuous with the apex of the funicle. The cotyledons are equal, very small, and mutually applied by their plane contiguous faces. The plumule is inconspicuous, and only indicated by a rounded, entire, very minute elevation. The lower half of the embryo is lodged in lax, apparently dislocated tissue.

[Roxburgh * describes the seed of *G. scandens* as having, besides the two outer coats, which he refers to the fruit, "two integuments: the exterior one thin and fibrous; the inner one less distinct, and adhering to the perisperm very firmly. Perisperm conform to the seed, cartilaginous. Embryo in the apex of the perisperm, straight. Cotyledons two, ensiform, unequal. Radicle superior." In his drawing of *G. scandens* the embryo is represented with a short obtuse radicle, two unequal cotyledons, and an immense plumule, consisting of a filiform stalk equalling in length the larger cotyledon, bearing at its apex two small leaflets. Nothing is said of the funiculus.]

From the foregoing account, I trust it will be seen that, with the exception of the subsequent and sudden appearance of the additional membrane †, the development of the ovula of *Gnetum* presents scarcely a single peculiarity worthy of notice. The changes that occur in the two outer coats from an early period up to the time of the maturity of the seed, I consider as of secondary importance, and as the result of modifications depending upon their anomalous situation. The sudden appearance of the additional membrane does not seem to me to be capable of any explanation: hitherto I have not met with it in any stage of development prior to that when its apex reaches to the opening existing in the outer coat. I can assert with tolerable confidence, that this coat does not originate in a separation of the circumferential tissue of the nucleus, and that hence it is not analogous to the *tercine*. I am unable to state what functions it performs, although its exsertion, its free communication with the apex of the nucleus, its dilated laciniate apex, and its subsequent sphacelation would lead us to suppose that it is connected with impregnation. If such be really the case, it is obvious, from the period at which its development is completed, that fecundation can only be effected through the agency of the pollen of anthers belonging to spikes at an earlier period of growth.

The complete agreement in development of the nucleus and albumen with that of the

* Flora Indica, vol. iii. p. 519.

† Roxburgh, in his figure of *G. scandens*, represents the exsertion of this membrane or coat as occurring during the existence of the male flowers.

same parts in ordinary ovula, precludes the necessity of any remark; neither is there any feature in the embryo, excepting its enormously long funiculus, that would lead me to suspect any material deviation from the usual structure.

The only genera of *Coniferæ* with which I have been able to compare *Gnetum* are *Agathis* and *Thuja*, in both of which the nucleus has only one envelope, its cavity being in *Agathis* lined with a very distinct amnios. The males of neither of these genera, however, exist in the Botanical Garden at Calcutta; and neither of them appears to possess that power, which exists to such a degree in *Cycas* and *Gnetum*, of continuing the development of the ovulum independently of fecundation. With *Cycadeæ* I have had ample opportunities of comparison, so far, at least, as regards the young ovula and perfect fruit. The mutual resemblance is, indeed, so strong, that I have little hesitation in affirming that the fruit of *Cycas* differs only *materially* from that of *Gnetum* in the absence of an additional envelope, *and perhaps* in the presence of the remains of the amnios. With regard to the ovula of *Cycas*, the nucleus has, as Dr. Brown has stated in the Memoir referred to, p. 24, only one envelope; but I have no doubt, both from the difference in its tissue, in which there is, indeed, an obvious line of demarcation, as well as from the disposition of its vessels, that it consists of two, united throughout their whole extent. The nucleus is likewise united by its lower portion to the envelope,—its apex, which is conical, being free, and prolonged into a membranous point, which is engaged within the lower part of the canal formed by the opening that exists through the coat. This membranous portion is tubular, the cavity extending some distance within the actual substance of the nucleus: its walls are cellular, and not lined by any membrane.

The body of the nucleus contains a large globular cavity, in which a sac of a corresponding size and form exists. This sac (the amnios) is, at the period referred to, membranous, and is rendered tense by an abundant gelatinous fluid; it is easily detached, and appears to be merely applied to the walls of the cavity.

I hope to be able at some future period to enter into more detail on the subject of the development of the ovula of *Cycas*, which appears to promise several new and highly interesting facts, particularly as regards the first appearance of cellular tissue within the sac of the amnios, while at the same time its great size renders it peculiarly fitted for observation.

It is probable that the fruit represented by Dr. Hooker (Bot. Mag. new ser. vol. ii. t. 2827) as that of *Cycas circinalis*, belongs to another species. The true *C. circinalis* has, as Richard has stated, a fungous envelope surrounding the albumen, which is of considerable thickness towards the base of the fruit, or rather seed; a thin membrane, probably the remains of the amnios, being interposed, and adhering to the fungous envelope, except towards its apex. In this species the cotyledons are, as M. Richard has likewise stated, united, except at their bases, where a free exit is allowed for the plumule on both sides. Dr. Hooker's description, particularly as regards the *coats*, agrees much better with *C. sphærica*, Roxb. The sacs existing in the apex of the albumen, first pointed out by Dr. Brown *, are in *C. circinalis* permanent; that in which the embryo is developed

* Prodr. Floræ Novæ Hollandiæ, vol. i. p. 347.

becoming necessarily much enlarged, and adhering firmly to the walls of the cavity it lines.

Although I have repeatedly examined the ovula of *Gnetum* with a view to the nature of their impregnation*, I am not in possession of a single fact relative to its performance. I must, however, mention, that the ovula of *Gnetum scandens* and *lepidotum* do not appear to be ever submitted to the action of the pollen derived from their *proper* male flowers. In *G. Brunonianum* this is obviated by the extreme smallness of the annulate involucrum. My residence at the Botanical Garden of Calcutta, and the great and unvarying kindness of Dr. Wallich, have put me in possession of some, I think, interesting facts relative to the impregnation of *Cycas*, which it may not be amiss to state. I may here observe, that the consideration of the mode of application of the pollen-tubes to the apex of the nucleus in some plants possessing the ordinary structure of ovarium, had led me to suppose that these productions are merely organs of communication, developed on account of the distance that necessarily exists in these plants between the stigmatic surface and ovulum, and that hence, in *Cycas* and plants of a similar simple structure, in which actual application of the pollen itself to the apex of the nucleus can obviously take place, no pollen-tubes would be produced.

In forming this view, I had not lost sight of the apparent penetration of the pollen-tubes *into* the ovula of *Asclepiadeæ*, first observed by Dr. Brown; but I supposed that it might be the result of the anomalous formation of the nucleus in these cases. Repeated observation has since, however, taught me, that not only does application of the pollen-granules to the apex of the nucleus of *Cycas* take place, but that pollen-tubes are likewise generated, although, as might be expected, much shorter than usual. Indeed, the tubular membranous portion of the apex of the nucleus becomes actually crammed with pollen-granules, from the lower and outer of which pollen-tubes are pretty generally produced.

The orifice of the envelope of *Cycas* has a callous and shining appearance; and although I have often examined pollen-grains which had been in apposition with it for some time, I have never seen any production of boyaux, except in the cavity of the apex of the nucleus.

Although I have by no means proved the *necessity* of the production of the pollen-tubes in *Cycas* to ensure fecundation, I consider the fact of their production a strong argument in favour of the idea that actual penetration does occur in every case in which the application of the tubes to the apex of the nucleus can be conceived. The fact of the production of the tubes likewise seems to me to put the nature of the bodies from which they originate out of all doubt, and to prove the truth of Dr. Brown's remark (Memoir cited, p. 30), that it would be quite gratuitous, on the grounds stated, to consider the particles contained in the thecæ to be analogous to the fovilla.

Dr. Brown, in his account of microscopical observations on the particles contained in the pollen of plants, published in the 'Edinburgh Journal of Science,' vol. ix. p. 343,

* The opening of the outer coat never presents a shining appearance.

says, after alluding to his want of success in tracing the particles contained in pollen-grains through the tissue of the style, "Even in those families in which I have supposed the ovulum to be naked, namely *Cycadeæ* and *Coniferæ*, I am inclined to think that the direct action of these particles, or of the pollen containing them, is exerted rather on the orifice of the proper membrane than on the apex of the included nucleus; —an opinion which is in part founded on the partial withering confined to one side of the orifice of that membrane in the Larch,—an appearance which I have remarked for several years." It is, however, most probable that, from the late rapid increase of our knowledge of the process of fecundation in Phænogamous plants, chiefly indeed owing to the beautiful observations of this distinguished botanist, the opinion above cited has been modified by its author.

With regard to the two principal objections urged by Dr. Brown * against the opinion of the female flower of *Cycadeæ* and *Coniferæ* being a naked pistillum, the first, viz. that arising "from the perforation of the pistillum, and the exposure of that point of the ovulum where the embryo is formed to the direct action of the pollen," still holds good. The second, viz. the too great simplicity of structure of the supposed ovulum, I look upon as in a great measure destroyed by the reduction of the usual number of the constituent parts of this organ in *Loranthaceæ*†.

Respecting the male flower, I have to add, that Linnæus was correct in referring the genus to *Monœcia Monadelphia*. Roxburgh adopts the same view in his MS. Synopsis; but in his 'Flora Indica' he refers it to the *Monœcia Monandria*. The correctness of Linnæus's view is proved by the fact that there are two filaments at an early period, or at least that their union is only partial, and by the number, situation, and distribution of the vascular fascicles.

GNETACEÆ, Lindley, in Bot. Register, vol. vii. N. S. t. 1686, sub *Garrya*.

DIAGNOSIS.—*Plantæ* gymnospermæ, dicotyledoneæ, aquosæ. *Rami* articulati. *Folia* opposita, indivisa, venis anastomosantibus reticulata.

CHAR. ESSENTIALIS.—*Flores* monoici, in spicis amentiformibus verticillatim dispositi; verticillus singulus involucro annulato integerrimo (rarius obsoleto) suffultus distans. MASCULI pluriseriati, in verticillis inferius dispositi. Perianthium tubulosum, inverse subulato-conicum fere cuneatum, mutuâ pressione angulatum, apice planiusculo vel depresso, rimâ transversâ dehiscens, carnosum. *Filamentum* unicum, monadelphum (e 2 nempe coalitis formatum), hypogynum, clavatum, per anthesin per rimam transversam exsertum. *Antheræ* duæ, uniloculares, basibus affixæ, erectæ; loculi omnino discreti longitudinaliter et centraliter secus latus utrumque dehiscentes. *Pollen* simplex, læve, oblongum.—FŒMINEI in verticillis superius dispositi, 1- vel 2-seriati. *Perianthium* nullum. *Ovula* ovata, sæpe obliqua, transverse sita, orthotropa. (*Junius.*) Tegumenta bina; exterius fibroso-cellulosum, interius cellulosum, sæpius inclusum, utrumque apice apertum. *Nucleus* cellulosus tegumento conformis, liber. (*Maturius.*) Tegumenta terna; tertium novumque nucleum cingens, supra ejus apicem in tubum cylindricum styliformem longe exsertum ore dilatato marginibusque laciniatis productum. *Fructus* (semen maturum) omnino exsertus, sessilis vel stipitatus, drupaceus, lævis vel lepidotus, ovatus, indehiscens. Sarcocarpium extus cellulosum, intus fibrosum (fibræ utrinque acutæ pungentes, diametro magno, coloratæ), apice perforatum. Endocarpium fibrosum, fragile, subosseum, sarcocarpio adnatum, e fibris longitudinaliter cellulisque transverse sitis

* '*Kingia*,' p. 28.

† See my Paper on this subject.

formatum, apice apertum. Tegumentum tertium fibroso-cellulosum albumen amplectens, apice in apiculum subulatum induratum endocarpium et sarcocarpium perforantem sed vix exsertum productum. *Albumen* semini conforme, carnosum, copiosum, apice membranâ apiculatâ lacerâ sphacelatâ (nuclei reliquiis) incomplete tectum, intus excavatum. *Embryo* inversus, in excavatione albuminis reconditus, ope funiculi longissimi (3–5 uncialis) cellulosi, spiraliter torti, albuminis excavationi lateraliter et apicem versus affixi sustentus. *Radicula* conica, supera, cum texturâ apicis funiculi continua. Cotyledones parvæ, æquales. *Plumula* inconspicua.—Arbusculæ, fruticesve *sæpius scandentes succo aquoso fœti.* Truncus *conicus, ramosus.* Lignum *fibroso-vasculosum, zonatum; zonis concentricis maxime evolutis, e radiis medullariis inter se lateraliter confluentibus formatis; e vasis maximis glanduloso-punctatis* (*more* Coniferarum) *fibrisque ligneis crebre punctatis constans.* Rami *articulati ramulique virides ad articulos tumidi.* Folia *opposita, petiolata; petioli superne plani inferne convexi, basibus in annulum intrapetiolarem* (*fere ut in* Potaliaceis) *connati.* Limbus *indivisus, ovato- vel lanceolato-oblongus, plus minus acuminatus, sæpius repandus, integer, penninervis, nervis venis secundariis et tertiariis arcuatim coalitis, supra secus nervum centralem et bases secundariorum stomatibus donata; infra per totam superficiem venis venulisque exceptis organis iisdem donata.*—(See Note 1.) Folia *novella per vernationem paginis superioribus planis mutuo et arcte approximata.* Inflorescentia *paniculatim spicata, axillaris vel sæpius terminalis. Spicæ cylindricæ,* 3 *in quâque divisione paniculæ; laterales oppositæ pedunculatæ* (*pedunculi ad bases annulo obsoleto cincti*); *terminalis longius pedunculatus, pedunculus supra medium bracteis* 2 *ovatis alte connatis stipatus.* Involucra *annuliformia, primo approximata demum discreta vel distantia; infima spicarum præsertim lateralium biapiculata.* Flores *pilis cellulosis articulatis quasi moniliformibus immixti præsertim fœminei; utriusque sexûs arcte verticillati, radiatimque patentes.* Masculi *inferiores, et in seriebus pluribus dispositi.* Fœminei *superiores,* 1 *vel* 2 *seriales, per anthesin involucro pilisque sæpius omnino obtecti; floribus masculis delapsis cito exserti, et demum omnino nudi.*

I shall conclude with a synopsis of the species I have ascertained to be indigenous to the Tenasserim Provinces.

GNETUM, Linn., Mantissa, p. 18, no. 1278.

Character ordinis.

Sectio I. *Erecta.*

G. BRUNONIANUM, mihi; fruticosum; foliis lanceolato-oblongis (membranaceis), involucris obsoletis.

Hab. in sylvis ad Banlau, urbem antiquam anglice Tenasserim dictam prope, florens ab Aprile usque ad Februarium. Fructus non vidi. Frutex humilis, erectus; ramis divaricatis. Folia breviter petiolata, subrepanda. Spicæ axillares et terminales, sæpius solitariæ; flores fœminei *exserti*, 1-seriati, virides, pilis cellulosis albis immixti.

Sectio II. *Scandentia.*

G. APICULATUM, mihi; foliis lanceolato-oblongis, fructibus sessilibus acutis lævibus.

Hab. in Silhet, *Roxb.* Arracan, *Capt. Margrave.* Legi in sylvis circa Mergui, oræ Tenasserim. Frutex longe scandens; folia coriacea, subacuminata. Flores pilis cellulosis *brunneis* immixti, fœminei per anthesin, marium omnino obtecti. Fructus (lanceolato-ovati) apiculati, omnino læves.

G. SCANDENS, Roxb.; foliis ovato-oblongis vel ovalibus, fructibus breve stipitatis obtusis lepidotis. *Ula*, Hort. Mal. vol. vii. p. 41. t. 22 opt. *Gnetum scandens*, Roxb. MSS. Synopsis; ejusdem Icones pictæ in Horto Botanico Calcuttense asservatæ, Suppl. vol. iv. t. 73; Flora Indica, vol. iii. p. 518.

Hab. in sylvis oræ Tenasserim. Legi ad Moulmein, Amherst, et Mergui. Floret Decembre, Januario. Frutex longe scandens. Folia coriacea, obtuse acuminata, supra atro-viridia, raro pallida. Paniculæ terminales. Flores utriusque sexûs pilis cellulosis albidis immixti. Fructus (ovato-oblongi), præsertim juniores, pulcherrime argenteo-lepidoti.

Under this species Roxburgh has confounded two distinct plants. In the drawing quoted above he has figured the fruit of *G. apiculatum* and of *G. scandens* as the produce of the same plant. In his description of the fruit of *G. scandens*, he seems to advert, although obscurely, to some peculiarity of the superficies, at least before maturity. This species is at once known by the silvery scales of the fruit, which are very conspicuous before it begins to assume its orange colour; these scales are peltate, closely appressed, and composed of cells radiating from the situation of the attachment.

I have not quoted Rumph, whose figure does not at all resemble our plant. Buchanan's synonym in Rees's Cyclopædia, founded on the supposed identity of Rumph's plant with the above, is therefore not to be taken without great hesitation.

Note 1.—(*Stomata.*) The arrangement above referred to is not uncommon, but perhaps limited to those leaves in which the parenchyma is continued *over* the veins. It is remarkable that in these cases the stomata differ considerably in size; those of the upper surface I have hitherto found to be the largest. As good instances of such distribution, I may mention *Costus speciosus*, and perhaps all species of *Nymphæa*. A curious, and I believe hitherto unnoticed singularity occurs in the distribution of these organs in *Nelumbium speciosum*, in which the callous spot in the centre of the leaf, and opposite to the termination of the petiole, is crowded with stomata of a large size, to the presence of which the unusual colour of the *spot* appears to be partly owing. These organs in this plant certainly open into cavities, through which they communicate indirectly with the cavities in the petiole, from the apex of which they radiate into the limb. The remainder of the vast limb is minutely papillose, the papillæ being depressed at their apices; and its stomata are very indistinct, and indeed almost obsolete.

Note 2.—Dr. Lindley, in the 'Botanical Register' quoted above, states that the wood of *Gnetum* is zoneless. In the climbing species the zones are highly developed, but in *G. Brunonianum* no zones existed; this is, however, in all probability referable to the specimens that I examined being the growth of one season. I have much pleasure in confirming the statement of the above author respecting the presence of spiral vessels, at least in the young parts. I may add, that the proportion of vessels appears to me very considerable.

Finally, the three families characterized by having the female flowers reduced to naked ovula, agree in the following remarkable points: viz. peculiar punctation of certain parts of their tissue, unisexuality, orthotropous ovula, and in the presence of at least two, often more, opposite cotyledons.

Aug. 4th, 1835.

EXPLANATION OF THE PLATES.

Tab. LV.

Fig. 1. Very young ovule of *Gnetum scandens* viewed on its upper or posterior surface, which is observed to be cleft longitudinally.

Fig. 2. Second envelope, showing its divided apex, the laciniæ of which are connivent. This coat is visible at *a* in fig. 1.

Fig. 3. Nucleus of the same, both coats being removed.

Fig. 4. Posterior view of an ovule (long before the dehiscence of the anthers), showing the longitudinal cleft, the margins of the upper part of which are in this case, and indeed generally at a period rather later than that to which figs. 1–3 refer, in apposition; part of the second coat is visible at *a*, and another portion projects through the apex at *b*.

Fig. 5. Inferior or anterior view of the same ovule, along which no fissure is visible.

Fig. 6. View of the inner or second coat, showing its irregularly-divided apex.

Fig. 7. Nucleus highly magnified (the coats removed), showing the depression at the apex and the central conical elevation.

Fig. 8. Apex of the nucleus; the conical elevation appears emarginate.

Fig. 9. Ovule of *G. Brunonianum*; no fissure through the outer coat except at the apex.

Fig. 10. Longitudinal section; the apex of the inner coat is visible on a level with that of the outer coat. A central cavity enclosing the remains of a sac is visible within the nucleus.

Fig. 11. Transverse section of the same.

Fig. 12. The inner coat, with part of the outer remaining at the base. This figure shows the narrow, deeply-divided apex of this coat.

Fig. 13. Nucleus, with half the bases of the coats remaining.

Fig. 14. Ovule of *G. Brunonianum* some time after the fall of the male flowers; at its apex are visible several projecting processes of cellular tissue.

Fig. 15. Vertical section of the same, showing that a new coat has been developed between the inner (now second) coat and the nucleus. This coat is prolonged beyond the nucleus into a cylindrical tube, the mouth of which is divided, and projects slightly beyond the opening through the apex of the outer envelope. The second coat is now tinged with yellow.

Fig. 16. Ovule with outer coat detached; the tubular prolongation is seen to project considerably beyond the opening in the apex of the second coat. The fimbriæ of the extremity of the tube have not yet become expanded.

Fig. 17. The same with the second coat removed, showing the third coat throughout.

Fig. 18. Vertical section of an ovule of *G. Brunonianum*, showing the parts *in situ*. The apex of the second coat is preserved entire: the correspondence of the apex of the nucleus to the commencement of the tubular prolongation, the expanding fimbriæ of this, and the adhesion with the base of the nucleus, are represented. The *tube* is not much sphacelated at this period. The terminations of the vascular fascicles at the base of the nucleus are shown.

Fig. 19. Transverse section of the ovule near its apex, showing the two envelopes and a portion of the tubular prolongation.

Fig. 20. Vertical section of the whole of the third envelope and the nucleus. At the base of the nucleus appear the terminations of the vessels; but this is only apparent, the vessels being cut through as they diverge outwards to pass into the envelopes; none exist in the nucleus.

Fig. 21. Vertical section of the immature fruit of *Gnetum apiculatum*, some time after the fall of the

exserted portion of the tubular prolongation. The prolonged apex of the outer coat (*a*) is distinct, as well as the formation of the large yellowish fibres. The second coat (*b*) has become thicker towards its apex, and somewhat indurated. The inner or additional coat (*c*) is now adherent to the nucleus throughout the greater part of the extent of this latter organ. That part of it which corresponds to the constricted apex of the nucleus is thickened; its prolongation is considerably dilated after it has passed through the narrow, and now cylindrical, tubular perforation of the second coat. The excavation is large, and its margins are rugged and more or less blackened.

Fig. 22. Vertical section of an ovule of *G. scandens*; the nucleus is surrounded inferiorly by the two outer coats; the notch on either side (*a*, *a*) indicates the place of separation of the additional (third) coat. The cavity is much enlarged, and occupied by a clavate body, of which the outline is given in the adjoining figure 23.

Fig. 23. Body occupying the nucleary cavity; this is the rudiment of that which subsequently becomes the very copious fleshy albumen.

Fig. 24. Vertical section of a full-grown fruit of *G. apiculatum*, in which, however, no embryo had been developed: *a*. outer baccate coat, the inner half of which is composed of very large fibres; these are of a yellowish colour, shining appearance, and imbedded in a reddish-yellow pulp; *b*, *b*. drupaceous covering; *c*, *c*, *c*. inner or additional coat, with its woody, fragile, enclosed and prolonged apex (to this the fourth coat adheres firmly, except at its sphacelated apex, *d*); *e*. albumen, now copious and fleshy, by the great development of which the original nucleus has become reduced to a thin membrane, of which the free apex is seen at *d*; *f*. excavation at the apex of the albumen occupied by broken-up tortuous tissue, the rudiments of a funiculus. The direction of the subsequently-extended excavation may be traced lower down, and is indicated by a greater density of texture than occurs elsewhere.

Fig. 25. Albumen of the same detached, viewed on its entire surface: at *d*. is seen the apex of the nucleary membrane with its sphacelated apiculus.

Fig. 26. Vertical section of the same, showing the cap which the adhering apex of the fourth or nucleary membrane makes for it. The tortuous tissue is visible in the cavity.

Tab. LVI.

Fig. 27. Considerably advanced ovule of *G. Brunonianum*; vertical section.

Fig. 28. Vertical section of a mature and, with the exception of the embryo, fully-formed seed of *G. scandens*: *a*, *a*, *a*. the outer coat, which has become pulpy and baccate, the fibres lying rather loosely in the pulp; it is perforated by the prolonged persistent apex of the third covering (*c*); *b*, *b*, *b*. the second or drupaceous coat, shown to consist of two layers also perforated at the apex; *c*, *c*, *c*. the third membrane, composed of the additional and nuclear membranes; these are united except at their apices,—the apex of the nucleary membrane always separating with the albumen, and forming for it an irregular lacerated cap; *d*. albumen; *e*. the central apical cavity, empty.

Fig. 29. Vertical section of an immature seed of *G. apiculatum*: *a*. outer coat; *b*. second coat; *c*. nucleary membrane of albumen; *d*. albumen; *e*. sphacelated apex of albumen; *f*. apical cavity; *g*. tortuous suspensor lodged in ditto.

Fig. 30. Tortuous suspensor (*g*) in fig. 29 extracted and highly magnified.

Fig. 31. Vertical section of the separated albumen of a similar seed.

Fig. 32. Vertical section of the albumen with its cellular attachment; showing the embryo *in situ* and its lateral attachment.

Fig. 33. Embryo and funiculus extracted and highly magnified, showing the lateral attachment.

Fig. 34. Embryo with the apex of the funiculus; the cotyledons are seen to be remarkably small and equal.

Fig. 35. The same, the embryo varied in shape.

Fig. 36. The same, with one of the cotyledons removed, showing the rudimentary plumule.

Fig. 37. Portion of the centre of the funiculus, showing the spiral disposition.

Fig. 38. Portion of inflorescence of *G. apiculatum*; the ovules are totally concealed and surrounded by very dense brown hairs. Exsertion of the stamina has taken place.

Fig. 39. Portion of inflorescence of *G. scandens*; the ovules are totally concealed, and the filaments are exserted to a considerable length; the transverse opening through the male perianth is represented.

Fig. 40. A verticil viewed from above, showing the ovules *in situ*, and partially surrounded with hairs. In this species the ovules are arranged in about two series, and the fissure is visible at the apices of some.

Fig. 41. Portion of inflorescence of *G. Brunonianum*, including one verticil with its obsolete ring (involucre). In this species the ovules are completely exposed at this period, their bases being surrounded with hairs; they are arranged in one series: some of the stamens are exserted.

Fig. 42. Portion of the spike of *G. scandens*, representing the ovules fully exposed, and the exsertion of the tubular prolongation of the additional or third membrane.

Fig. 43. Stamen of *G. Brunonianum* (?) at an early period; the filaments are still distinct at their bases; the number, direction, and termination of the vascular fasciculi are shown.

Fig. 44. Male flower of *G. Brunonianum* (?) before dehiscence.

Fig. 45. Stamen of the same, the base of the perianth partly remaining; the anthers have dehisced.

Fig. 46. Pollen of the same.

Fig. 47. The same after immersion in water.